CLAIMS

We claim:

1. A storage system, comprising:

a nanostructured storage material, comprising:

a network of a plurality of light elements, wherein the light elements are selected from the group consisting of Be, B, C, N, O, F, Mg, P, S, and Cl, wherein

the plurality of light elements are coupled by modified sp^2 bonds.

2. The storage system of claim 1, wherein

the binding energy of hydrogen to the nanostructured storage material with modified sp^2 bonds is greater than the binding energy of hydrogen to the nanostructured storage material with unmodified sp^2 bonds, wherein

hydrogen has a binding energy to the nanostructured storage material.

3. The storage system of claim 2, wherein

the binding energy of hydrogen to the nanostructured storage material with modified sp^2 bonds is greater than about 0.10 eV.

4. The storage system of claim 1, wherein

the desorption temperature of hydrogen to the nanostructured storage material with modified sp^2 bonds is greater than the desorption temperature of hydrogen to the nanostructured storage material with unmodified sp^2 bonds, wherein

hydrogen has a desorption temperature to the nanostructured storage material.

5. The storage system of claim 4, wherein

the desorption temperature of hydrogen to the nanostructured storage material is greater than about 60K.

6. The storage system of claim 4, wherein

the nanostructured storage material with modified sp^2 bonds is capable of adsorbing more hydrogen than the nanostructured storage material with unmodified sp^2 bonds in a range of temperatures around the desorption temperature of hydrogen, wherein

the nanostructured material is capable of adsorbing hydrogen.

7. The storage system of claim 1, wherein

the nanostructured storage material has a chemical composition that modifies the sp^2 bonds, wherein

the nanostructured storage material has a chemical composition.

8. The storage system of claim 7, wherein

the chemical composition of the nanostructured storage material is $B_xC_yN_z$, BN, BC_2N, C_3N_4, MgB_2, Be_3N_2, BeB_2, B_2O, B, BeO, $AlCl_3$, Al_4C_3, AlF_3, Al_2O_3, Al_2S_3, Mg_2Si, Mg_3N_2, Li_3N, Li_2S, Na_2S, AlB_2, or Na_2S_4, and mixtures of the above, wherein x, y, and z are integers.

9. The storage system of claim 1, wherein

the nanostructured storage material has a non-planar shape that modifies the sp^2 bonds.

10. The storage system of claim 9, wherein the non-planar shape comprises:

at least one of a thin nanoplatelet, a thick nanoplatelet, and an intercalated nanoplatelet.

11. The storage system of claim 10, wherein the at least one of a thin nanoplatelet, a thick nanoplatelet, and an intercalated nanoplatelet is in heterogeneous form.

12. The storage system of claim 9, wherein the non-planar shape comprises:

at least one of an empty nanocage, a filled nanocage, a multifaceted nanocage, an empty nanococoon, a filled nanococoon, a multifaceted nanococoon, a nanotorus, a nanocoil, a buckyball, and a nanohorn.

13. The storage system of claim 12, wherein the at least one of an empty nanocage, a filled nanocage, a multifaceted nanocage, an empty nanococoon, a filled nanococoon, a multifaceted nanococoon, a nanotorus, a nanocoil, a buckyball, and a nanohorn is in a heterogeneous form.

14. The storage system of claim 9, wherein the non-planar shape comprises:

at least one of a single walled nanotube, a double walled nanotube, a multi walled nanotube, a nanotube with zig-zag chirality, a nanotube with a mixture of chiralities, a twisted nanotube, a straight nanotube, a bent nanotube, a kinked nanotube, a curled nanotube, a flattened nanotube, a round nanotube, a turbostratic nanofiber, a highly oriented nanofiber, a twisted nanofiber, a straight nanofiber, a curled nanofiber, a rigid nanofiber, a nanorod, a nanowire, a rope of nanotubes, a braid of nanotubes, and a bundle of nanotubes.

15. The storage system of claim 14, wherein the at least one of a single walled nanotube, a double walled nanotube, a multi walled nanotube, a nanotube with zig-zag chirality, a nanotube with a mixture of chiralities, a twisted nanotube, a straight nanotube, a bent nanotube, a kinked nanotube, a curled nanotube, a flattened nanotube, a round nanotube, a turbostratic nanofiber, a highly oriented nanofiber, a twisted nanofiber, a straight nanofiber, a curled nanofiber, a rigid nanofiber, a nanorod, a nanowire, a rope of nanotubes, a braid of nanotubes, and a bundle of nanotubes is in a heterogeneous form.

16. The storage system of claim 1, wherein the nanostructured storage material comprises a plurality of defects that modify the sp^2 bonds.

17. The storage system of claim 16, wherein the plurality of defects comprise light elements of a first kind implanted into a network of light elements of a second kind.

18. The storage system of claim 16, wherein the plurality of defects comprise light elements of a first kind implanted into a network of light elements of a second kind and a third kind.

19. The storage system of claim 16, wherein the plurality of defects comprise a plurality of light elements removed from the network of plurality of light elements.

20. The storage system of claim 19, wherein the plurality of defects comprise a plurality of hydrogen atoms coupled to the network of the plurality of the light elements in place of the removed plurality of light elements.

21. The storage system of claim 16, wherein the plurality of defects comprise a plurality of pentagons of the light elements, and a plurality of heptagons of the light elements.

22. The storage system of claim 21, wherein pentagons of light elements and heptagons of light elements are neighbors, forming 5-7 pairs.

23. The storage system of claim 1, wherein

the nanostructured storage material further comprises a plurality of donor atoms, coupled to the nanostructured storage material to transfer charges onto the plurality of light elements that modify the sp^2 bonds.

24. The storage system of claim 1, wherein

the nanostructured storage material further comprises a plurality of acceptor atoms, coupled to the nanostructured storage material to transfer charges from the plurality of light elements that modify the sp^2 bonds.

25. A storage system, comprising:

a nanostructured storage means, comprising:

a network means of a plurality of light elements, wherein the light elements are selected from the group consisting of Be, B, C, N, O, F, Mg, P, S, and Cl, wherein

the plurality of light elements are coupled by modified sp^2 bonds.

26. A method of forming a storage system, the method comprising:

selecting a plurality of light elements from the group consisting of Be, B, C, N, O, F, Mg, P, S, and Cl; and

forming a nanostructured storage material, comprising:

forming a network of the selected plurality of light elements with modified sp^2 bonds.

27. The claim of 26, wherein forming the nanostructured storage material comprises:

forming the nanostructured storage material with modified sp^2 bonds capable of storing more hydrogen than the nanostructured storage material with unmodified sp^2 bonds, wherein the nanostructured material is capable of storing

hydrogen.

28. The storage system of claim 26, wherein forming the nanostructured storage material comprises:

forming the nanostructured storage material with modified sp^2 bonds so that the binding energy of hydrogen to the nanostructured storage material with modified sp^2 bonds is greater than the binding energy of hydrogen to the nanostructured storage material with unmodified sp^2 bonds, wherein

hydrogen has a binding energy to the nanostructured storage material.

29. The storage system of claim 26, wherein forming the nanostructured storage material comprises:

forming the nanostructured storage material with modified sp^2 bonds so that the desorption temperature of hydrogen to the nanostructured storage material with modified sp^2 bonds is greater than the desorption temperature of hydrogen to the nanostructured storage material with unmodified sp^2 bonds, wherein

hydrogen has a desorption temperature to the nanostructured storage material.

30. The method of claim 26, wherein forming the nanostructured storage material comprises:

forming the nanostructured storage material with a chemical composition that modifies the sp^2 bonds, wherein

the nanostructured storage material has a chemical composition.

31. The method of claim 30, wherein forming the nanostructured storage material comprises:

including doping gases into the flow of the chemical vapor deposition synthesis, wherein

the nanostructured storage material is formed by a chemical vapor deposition synthesis.

32. The method of claim 31, wherein including doping gases into the flow comprises:

including a doping gas, selected from the group consisting of NH_3, CH_3NH_2, $(CH_3)_2NH$, $(CH_3)_3N$, BCl_3, BF_3, B_2H_6, a borohydride, SiH_4, Si_2H_6, $SiCl_4$, SiF_4, SiH_2Cl_2, H_2S, and PH_3.

33. The method of claim 30, wherein forming the nanostructured storage material comprises:

forming a powder mixture by introducing traces of selected elements into a graphite powder;

hot-pressing the powder mixture into a form, suitable for use as an electrode; and

using the hot-pressed powder as an electrode in an arc synthesis of nanostructured storage material.

34. The method of claim 30, wherein forming the nanostructured storage material comprises:

ball-milling the nanostructured storage material with a powder of a selected element.

35. The method of claim 26, wherein forming the nanostructured storage material comprises:

forming the nanostructured storage material with a non-planar shape that modifies the sp^2 bonds.

36. The method of claim 26, wherein forming the nanostructured storage material comprises:

forming the nanostructured storage material with a plurality of defects that modify the sp^2 bonds.

37. The method of claim 36, wherein forming the nanostructured storage material comprises:

exposing the nanostructured storage material to a flow of ozone; and

annealing the nanostructured storage material in a temperature range between about 400°C and about 1800°C.

38. The method of claim 37, wherein the annealing comprises:

annealing in one of a vacuum, a neutral atmosphere and a hydrogen containing atmosphere.

39. The method of claim 36, wherein forming the nanostructured storage material comprises:

removing light elements from the nanostructured storage material by a method, selected from the group of irradiation with electrons, neutrons, ions, gamma rays, X-rays, and microwaves.

40. The method of claim 36, wherein forming the nanostructured storage material comprises:

nucleating 5-7 pair defects by introducing at least one of cyclopentadiene, cycloheptatriene, and azulene, into the flow of the chemical vapor deposition synthesis, wherein

the nanostructured storage material is formed by a chemical vapor deposition synthesis.

41. The method of claim 26, wherein forming the nanostructured storage material comprises:

forming the nanostructured storage material with a charge transfer layer that modifies the sp^2 bonds, wherein

the charge transfer layer is capable of transferring electrons to or from the nanostructured material.

42. A method of storing hydrogen in a storage system, the method comprising:

providing a nanostructured storage material, comprising:

a network of a plurality of light elements, wherein the light elements are selected from the group consisting of Be, B, C, N, O, F, Mg, P, S, and Cl, wherein

the plurality of light elements are coupled by modified sp^2 bonds; and

storing hydrogen in the nanostructured storage material.